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Review of existing communication strategies

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The AquaticPollutantsTransNet partners have received funding from BMBF, ANR and SRC within the 2020 Transfer Project Call, implemented under the ERA-NET Cofund AquaticPollutants of the Joint Programming Initiatives (JPIs) on Water, Oceans and Antimicrobial Resistance (AMR).

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Authors	Gunnar Thorsén, Maité Fournier
Reviewers	Katie Carter (DECHEMA)
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1. Aim and scope

The aim of this report is to provide the AquaticPollutants (AP) projects with a brief literature summary concerning knowledge transfer techniques that have become more widely applied in recent years. The report does not therefore cover for instance lunch seminars, opinion pieces, popular science papers or policy briefs, that are usually implemented in many larger research projects. Instead, it focuses on knowledge transfer techniques such as social media presence, citizen science projects, videos for the general public, etc. It is not intended as a comprehensive coverage of the available literature, as the literature concerning some topics, such as science-to-policy strategies, is very extensive while other topics have not been studied comprehensively. This report rather focuses on illustrative examples highlighting some of the key elements of successful knowledge transfer strategies across different methods, such as instructional videos or social media accounts, where scientific evaluations of these have been attempted.

This report aims to provide the AP projects with a common knowledge base and may help to choose suitable knowledge transfer techniques for specific target or stakeholder groups. The overall goal is to help the AP projects engage more effectively and successfully with their target stakeholders, thus resulting in an improved transfer and uptake of the knowledge generated within the AP projects across society. The report therefore includes sections summarizing the communication tools that the AP projects have planned to use and a section evaluating these based on the information provided in the report.

The report focuses on the available guidance from the European Union (EU) and the communication activities to different stakeholders. It also provides a list of literature concerning policy windows, citizen science projects, information videos, co-creation processes for project leaders, communication work package leaders and communicators tied to the projects. One of the aims for this report is also to provide a common background for the co-creation processes that will be used in Work Package 2 (WP2) of the AquaticPollutantsTransNet project for the creation of innovative knowledge transfer strategies.

2. Maximizing the impact of research projects

When it comes to maximizing the impact of research projects, it is important to consider which strategies or methods should be used to transfer knowledge to different target audiences or stakeholders. This may not always align with the priorities of the scientist performing the research, as the career of a scientist often depends on a steady output of scientific papers. Policymakers, on the one hand, may not have the time and resources to read through a lot of peer reviewed papers, which limits the knowledge uptake from research projects. Policymakers may prefer to rather receive the knowledge in the form of policy briefs or through target seminars. As a further example, an engineer at a sewage treatment plant may be interested in new techniques for removal of chemicals of emerging concern (CECs) but has a more urgent focus on compounds that are regulated or that may get regulated in the near future. It is therefore beneficial to disseminate the knowledge in different ways to ensure that the desired target audience is reached.

To support scientists and other research professionals in achieving goals in line with the expectations of the funding bodies, the EU has published several guides and on-line resources covering the communication, dissemination and exploitation of results[1-3]. A summary of the definitions, objectives, focus and target audience of each of these possible impacts from a research project is presented in Table 1. In brief, communication is here considered to be aimed at a large and/or varied audience, dissemination is aimed at a narrower audience with a more specific interest in the research and exploitation at the further utilization of the research results. Communication can, for example, be aimed at society to highlight the value and benefit of the research for which common assets (research funding) have been used. Possible communication activities could be press releases with the aim of generating interviews in news channels, opinion pieces or popular science articles. Dissemination could, for instance, target the scientific community through peer reviewed papers or policymakers through policy briefs. Conference presentations, lunch seminars targeting specific stakeholders or networking are other activities that are commonly implemented in research projects. Exploitation could be the use of the results for future funding applications, building, deepening or expanding the research network or for writing patent applications and starting commercial enterprises. It is therefore very important to initially identify the desired target audience and the desired knowledge transfer goals when selecting the appropriate knowledge transfer strategy for the research project.

Table 1. Summary of the conecepts of communication, dissemination and exploitation.

	Communication	**Dissemination**	**Exploitation**
Definition	Process aiming at promoting the action and its results	The disclosure of the project results to the public	Utilisation of the project results in further activities in research, development or standardisation
Objective	Showing society the impact and benefits of EU-funded R&I activities	Transfer knowledge & results to enable the use and uptake of results	Effectively use project results, turning them into concrete value and impact for society
Focus	Inform and promote the project AND its results/success	Describe and ensure results available for others to USE	Make concrete use of research results (not only commercial)
Target Audience	Audiences beyond the project's community, e.g. media, broad public	Audiences with interest in the potential use of the results, e.g. the scientific community, policymakers	Stakeholders, including project partners, that make concrete use of the project results
Activities	Press release, media interviews, communication videos, opinion piece, popular science	Policy brief, conference presentation, scientific publishing, white paper, networking w stakeholders, lunch seminars	Network building, patent applications, stakeholder networking, new project applications

Source: Table adapted from [1].

3. Communication and dissemination tools planned by the AP projects

The 18 AP projects have a number of different communication and dissemination activities planned. At the start of the projects, an inventory of the activities was performed using information provided in the booklet of project descriptions and through a questionnaire that was sent to the AP projects by the TransNet project. The different types of knowledge transfer activities that are planned and the number of projects that are intending to include this type of method is summarized in Figure 1.

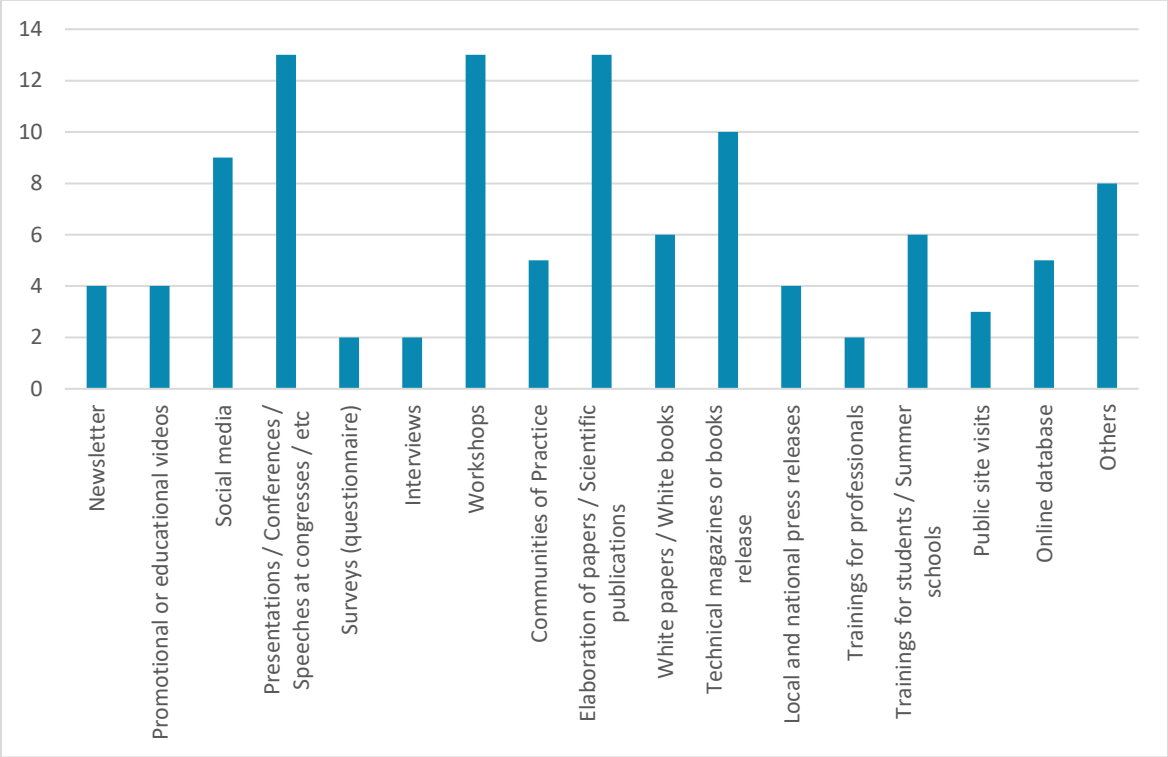

Figure 1. Number of knowledge transfer activities planned by the 18 AP projects, divided into 17 generalized categories.

The most common planned knowledge transfer methods are presentations at conferences, workshops, and scientific papers with 13 out of 18 projects planning these types of knowledge transfer activities. This is not surprising, and the results for scientific publications and presentations at conferences may even be considered as too low given that it is common for scientific research projects to strive for conference presentations and scientific papers as this is perhaps the principal merit for the scientists. Technical magazines or books and social media are the methods that are the next most common amongst the projects, with 10 and 9 projects respectively planning such activities. This is followed by training for students, authoring white papers, organizing communities of practice and creating online databases for which 5 to 6 projects have plans. Below this in frequency is newsletters (4), promotional or educational videos (4), press releases to traditional media outlets (4) and public site visits (3). Surveys, interviews and training for professionals are the methods for which fewest projects have plans, two projects each.

As seen in Figure 1, there are a wide range of knowledge transfer activities planned for the projects. In the category “Others” the following activities are listed:

1. Deposition of data in databases
2. On-site visits
3. Invitation for partners to project meetings
4. School visits or open days
5. Inclusion on the advisory board of representatives from industry
6. Research performed at demo-sites in collaboration with industry partners
7. Popular science paper
8. Press release
9. Participating in international networks
10. Establishing laboratory devices at partner lab in Africa

One observation is that there are a couple of projects that have more than one activity planned that fit in the “Others” category. Some of these activities are similar to ones in the initial categories even though there are differences between, for instance, the creation of a new database and deposition of data in an existing database.

There are big differences in how many activities are included and how active the different project are in their communication plans. Two projects did not provide enough information to assess the communication plans in the surveys performed at the start of the project. Four projects have only planned workshops and presentations at conferences, authoring of scientific papers or white papers while nine projects have extensive communication plans with activities planned in more than six categories. It should be noted that planning a wide range of activities may not reflect how well a project succeeds in transferring the desired knowledge to the target audience, but probably reflects how much effort has been used to draft a plan during the writing of the grant proposal. It could also reflect the communication experience of the project collaboration team.

Some of the planned activities are more applicable when communicating to a large, general audience or the general public, for instance local and national press releases, popular science papers, school visits or social media posts. Social media posts may, however, also be limited to a more tightly knitted group, depending on which followers and how active the project is at promoting their accounts. For the purpose of disseminating the results to target groups, other activities may be more efficient, such as: scientific publications, conference presentations, workshops, white papers, newsletters, involvement of industry in demo-sites, etc. There are also activities that may target a more general public or specific stakeholder groups, for instance interviews, surveys, educational or promotion videos, or public site visits.

A good plan is often a necessity for achieving a successful communication or dissemination of the results from a project. It is important that the required work should not be underestimated and undefined responsibilities for the knowledge transfer activities may impair the efficiency with which the activities are performed or result in activities not being implemented.

4. General guidance and recommendations

The communication guidelines for Horizon 2020 projects[3] provide some specific recommendations for funded projects that should result in an improved outreach. These are as follows:

Ensure good management: It is important to include the planning of communication, dissemination and exploitation of the project results already when writing the project proposal. Sufficient budget and resources must be allocated to communication activities that is aligned to the specific project. Including a specific communication work package is advantageous to more clearly define these activities. Getting all the partners active in the communication activities increases the possibility to reach the desired audiences, as well as strengthens the involvement in the project. Generating an awareness that communication is something that should be performed during the entire duration of the project and not just at the end of the project increases the chances for an effective communication, dissemination or exploitation of the results. Have professional communicators been involved in the project, perhaps already in the writing phase, or has relevant training been given to researchers or project managers? It is also important that the continuity of the communication has been secured so that the efforts that have been made during the project (web pages, social media accounts, etc.) do not disappear once the project is finished.

Define your goals and objectives: Do you have clearly defined goals and objectives for your research project, including what to communicate, disseminate and exploit? It is good to define the impact that is desired from the project. This could include raising the public awareness on an issue, relaying specific information to policymakers, or creating a start-up venture. It is, however, also important that the goals have the right level of ambition and are neither too ambitious nor too weak in proportion to the research project. Therefore, it is useful to have well defined goals and intermediate goals defined during the course of the project. Ensuring that the goals are measurable can be beneficial for the possibility of following up the progress or results of the project.

Pick your audience: It is usually advantageous to be able to define the audience well when targeting a group with a specific message or telling a compelling story rather than aiming for “the general public”. Targeting a specific age-group or profession can make the communication more effective. Examples of target audience groups are: industry, researchers, regulators, operators or solutions providers. The more well defined the group, the easier it is to tailor the message and choose the right strategy. For maximizing the outreach of the project, it is also good to consider whether all the relevant target groups are included.

Tailor your message to stakeholders: It is advantageous that the societal issue or question that the project is addressing is perceived as important and relevant for stakeholders. Therefore, it is beneficial if it is answering questions such as:

- Why do we need to know?
- What solutions does my project offer?
- What makes the issue urgent?
- What are the consequences if no action is taken?

Try to see the problem addressed through the eyes of the desired audience. It could be good to reflect upon if it is “news” and whether you are connecting what your audience wants to know to your own

objectives? It is often better to tell a story, rather than to only provide information if you need to get a message across or to get a good uptake of new knowledge.

Use the right medium and means: Will you reach the desired audience or can the methods or strategies used perhaps even reach beyond the obvious audience to one that were not initially considered? There are many ways to relay information or to communicate results, everything from two-way interaction, such as face-to-face or round-table discussions or conference presentations to one-way means such as webpages or opinion pieces. Choosing the appropriate means of communication is essential. Perhaps a combination of methods stated above is necessary.

Evaluate your efforts: At the end, it is good practice to evaluate whether the communication, dissemination or exploitation goals have been reached or what can be improved for future projects.

General recommendations for communication activities in EU-projects

- **Define your goals and objectives**
- **Pick your audience**
- **Tailor your message**
- **Use the right medium and means**
- **Evaluate your efforts**

5. Suggestions for improved communication to the general public

There are many strategies that can be used to communicate the results from a research project to a broader audience. Which methods are most suited for the transfer and uptake of the knowledge generated may differ between target groups. It may depend, for instance, on prior knowledge or on the media they are used to consuming. As "the successful transfer of knowledge" is a difficult thing to study, the literature on this topic is not extensive. In this report, we nevertheless try to provide some insights into what can make a strategy successful. Some concepts, such as the involvement of the general public in citizen science projects, have been studied more extensively than the use of social media or science communication through video streaming services such as YouTube.

The possibilities of reaching a wide and varied audience have changed dramatically over the past two decades. The possibility of reaching a global audience was previously reserved to a very small group of people through the traditional media cannels. Now that possibility, still being very small, exists for a great number of people independent of position in society. New concepts, ways and tools have led to a totally new landscape for communication. There is a growing amount of literature that is addressing this theoretically and reviews with relevant literature can be found in the review by Taddicken and Krämer[4].

5.1. Insights from a previous EU project on science communication

Owing to the perception that it is difficult to communicate science to the general public as well as to policy- or decision-makers, initiatives have been made over the last decades to improve the understanding of how to get the best outreach from a specific project or call. Obviously, this is driven by the funders regarding the amount of public funding that it made available for scientific research. For example, an EU Horizon 2020 funded project, the Concise project (concise-h2020.eu), aims to initiate a Europe-wide debate on science communication with a large and varied group of stakeholders in several European countries. The Concise project is in and of itself a Citizen Science project that organized public consultations in five EU countries engaging a total of 497 EU citizens.

Recommendations for communicators that have emerged out of the Concise project are to use a variety of tailored methods and tools and to increase the use of social media to target younger audiences. Further, it is recommended to only publish verified and relevant information based on factual data and scientific knowledge, using a science communication that is balanced, non-sensational and straightforward. It is beneficial to offer different levels of depth in the communication depending on the audience's capacity. The use of social media also gives the advantage of facilitating a two-way communication, but then sufficient resources must be allocated to this purpose.

Recommendations to communicators from the Concise project

- **Use a variety of tailored methods and tools**
- **Increase the use of social media to target younger audiences**
- **Only publish verified and relevant information based on factual data and scientific knowledge**
- **Use a science communication that is balanced, non-sensational and straightforward**
- **Offer different levels of depth in the communication**

5.2. The changing information landscape

Concerning communication research on knowledge transfer, the most studied theme that pertains to the scope of the AquaticPollutants call is that of antimicrobial resistance (AMR). There are not as much recent communication research presented concerning chemicals of emerging concern or pathogens. While most cases that have been studied have a focus on AMR, they should be applicable to other themes. The methods of communication and possibility of interacting with target audiences or stakeholders is rapidly changing and so are the ways of searching for information. With a more diverse media landscape there are more things that will have an effect on how people find and acquire information or knowledge[5]. From the belief that the main obstacle for assimilating knowledge was a lack of scientific literacy in the specific field, i.e. the knowledge deficit model, it has become more evident that many factors influence the transfer and uptake of knowledge[5]. The increased accessibility and multitude of sources of information has had a big impact on how scientific information is sought and consumed. This has, for instance, resulted in a greater possibility for people to seek information that is perceived as important, "salient", to them[6]. For the scientist, this implies that describing why the information is valuable has become more important[5]. The reasons why information is perceived as salient, however, may vary based on the type of information. For health-related information, the salience can be for selfish, or utilitarian, reasons while for science information the salience can be based on curiosity[6]. Concepts such as salience, trust[7], cultural predisposition, engagement, as well as ways of presenting information in a just-in-time information landscape is discussed in the following section for the case of knowledge transfer using videos, exemplified by specific studies that highlight important issues.

5.3. Information videos

One study that scientifically investigated the uptake of knowledge concerning AMR by information videos aimed at understanding whether one-sided information, as provided by a video, helped to increase the general awareness of antibiotic resistance[8]. It also attempted to investigate whether the effect was stronger for those with lower levels of knowledge compared to those with an initial higher level of knowledge. Finally, cultural predisposition was examined and found that reject information concerning AMR meant that the effect of the information was less strong.

To investigate this, a survey of the study subject was performed to group the subjects based on cultural predisposition and health beliefs. This provided information, for example, on whether a person was inclined to trust institutions, apathetic in the face of questions such as AMR, or generally worried about

issues such as these. The scientists concluded that the effect of the video was statistically significant, but only weakly and was more pronounced for those with a low level of prior knowledge. Key findings from the study could be related to that people with certain cultural profiles were not affected by the educational video, and that this may be linked to them already having developed strong views on the subject. In this case, the information in the video was rejected as it was contrary to already existing beliefs.

5.4. Common traits of popular videos on streaming platforms

One possible way to influence people or reach an audience beyond the most immediate stakeholders is through online streaming of videos. It is difficult to study the effectiveness of knowledge transfer of streaming videos on channels such as YouTube or TikTok, but the popularity or reach of a specific video clip can be studied. One study focused on the 41 most viewed YouTube videos and categorized these by which type of video that they represented: popular science (9 videos), journalism (9 videos), "YouTuber" (7 videos), curriculum resources (4 videos), medicinal entertainment (3 videos), public health campaign (3 videos) and advertising (2 videos)[9]. An analysis of the way the information is conveyed showed that popular science and public health campaign videos used a "fictionalized storytelling" with "super bugs" portrayed in a cartoon style with human traits. This was in many ways contrasted by the journalism videos that was dominated by a "personalized storytelling" often with the journalist him/herself telling the story of, for instance, patients that had suffered AMR-infections.

The category of "YouTuber" was found to be extremely varied in content and in many cases lacked a stringent agenda or a connection to a scientific field. The scientific relation was unclear, as often people were profiling their channel on some other topic, which may result in low trustworthiness. Curriculum resources were in essence narrated PowerPoint presentations. Medical entertainment was given as an epithet for videos that tried to attract audiences by showing visually disturbing pictures with a "high yuck-factor" to attract viewers. To increase engagement, the authors of the study´s recommendations included for popular science to learn from a more personalized storytelling to increase the engagement of the audience. Journalism, on the other hand, could make more use of visualizations and humor to offset the scare induced by victim and survival narratives.

There are some general recommendations for components that impact the popularity of a science video[10, 11]. One of these is identifying a dramatic question to be addressed. One example mentioned was: "Why are there 96,000,000 black balls on this reservoir?" Incorporating at least one moment of change, such as "and" or "but" in the narration has also been shown to be beneficial for maintaining the interest of the viewer. It is also good practice to clearly specify the insight of the content that is presented, with the aim to guide the viewer in what to look forward to.

One insight that was also emphasized in connection with a social media campaign promoting a specific project was the importance of evoking higher-arousal emotions – essentially any emotion that can be stimulated will be beneficial for capturing the audience's interest. One example is a feeling of suspense created by the narrator climbing a steep hill to reach an observation point suitable to describe the geology of the area, where the viewer can ask, "where does this lead to?". A last recommendation is to elevate the importance of the story to capture the audience.

Recommendations for the use of videos in communicating to the general public

- **(Previous knowledge may affect the susceptibility for information due to conformation bias?)**
- **Different types of storytelling may be used to either increase the engagement of, or to reduce the risk to scare away viewers**
- **Dramatic questions can be used to create an awareness of the video**
- **Introducing moments of change can help to maintain the interest of the viewer**
- **Clearly specify the insights of the content presented**
- **It is beneficial if the video can arouse emotions in the viewer**
- **Elevate the importance of the story that is being told**

5.5. Building a successful social media presence

One of the more important aspects of maintaining a successful social media account is the frequency of posting updates. If updates are posted too seldom, the audience (if initially captured) will be lost to other channels. A social media account that will enhance the impact of a research project should ideally be created as soon as a continuous presence can be maintained and relevant information or content be shared. It is a communication channel that has a possibility to reach audiences not initially intended in the communication strategy. It may also offer possibilities to have a two-way interaction between the project and an audience, which can result in more engagement from the audience, given that sufficient resources are allocated and the participants in the project can be motivated to contribute. Ideally, a project's progress and results should be engaging enough to motivate the participants to engage in the social media account, even though it is common that this is not that case.

Starting to post content too late in the project may lead to a very brief time period where the social media account will be active. This limits the possibilities and the channels will only reach the nearest possible audiences. To maximize the impact of a social media account, it may be good to conceive of a specific strategy for these activities. Usually, the content consists of short text updates, including pictures or short video clips. The recommendations for video clips above may be successfully implemented here.

One example examining the creation of a successful social media campaign with an examination of factors for success was performed as a research study. From examples of the above-mentioned recommendations, one that was given was the simple element of a presenter climbing up a steep hill to get to a summit, thus creating a bit of suspense and expectation, before describing the surrounding geology.

Recommendations for building a successful social media presence

- **A social media account requires frequent publishing to build and maintain an audience**
- **The social media account should be created as soon as a continuous presence can be maintained**
- **Two-way communication can increase the engagement of the audience**
- **Devise a specific strategy for the social media activities**

5.6. Citizen science projects

Citizen science projects have the advantage of deepening the engagement of the target audience, which usually results in a more successful uptake of the knowledge generated. In some instances, as highlighted below, citizen science projects may prosper within a community and the outreach of the project or platform may be wide. In other cases, a citizen science component in a larger project can lead to a better acceptance of the research within a community that is impacted by the research or can provide benefits as it can be used to acquire local or specific knowledge that an engaged group of citizens may possess. This could for instance be a decline of bird or fish populations within a specific region.

There are several things that could define a successful citizen science project. The most obvious is perhaps the engagement of the audience or stakeholders, but as citizen science projects often are initiated by scientists at universities or research institutes, the scientific output should also be an indicator[12]. One evaluation looking into the success of publishing showed that less than 20% of citizen science projects publish their results. This could imply that they are perhaps not scientifically successful. There was no knowledge on whether the projects had scientific goals or if these were met.

A study focusing on successful features of citizen science projects evaluated five highly productive projects on 15 common features, divided into four categories. The categories were goals, platform, community and dissemination. Examples of the features were scientific goals, educational goals, social goals, user friendly platform, smartphone application, whether it engages an existing community, if it has a network of supporting volunteers, if it provides access to raw data or facilitates dissemination of results. The projects evaluated were large and well established, for instance eBird, run by the Cornell Lab for Ornithology (https://ebird.org/home), and Foldit (https://fold.it/science), with eBird for instance receiving an input of more than 100 million bird sightings per year. The other projects were CoCoRaHS, Galaxy Zoo and OPAL.

The evaluation showed that the common features between all of these projects were scientific goals, user-friendly platform, availability of educational material, providing a social platform and that they facilitated the dissemination of results. Common features that four of the five projects shared was: having a smartphone application, that it provides online training and learning opportunities, and that it does not require previous knowledge. Finally, a project containing clearly defined scientific goals is valuable for any scientific project. A facilitated use of the platform influences the successfulness for a citizen science project, even though not all citizen science projects rely on a digital platform. The availability of educational materials that teachers can use in a classroom setting increases the possibility of recruiting new participants to the projects. Providing a social platform helps to create engagement and allows for building on existing communities. In certain citizen science projects, such as the Swedish “artportalen”, networks of knowledgeable participants can aid in verifying uncertain observations. Through the dissemination of results, users get feedback on what their contribution led to, which further engages citizens and may also lead to further expansion of the network or a further reach of the project outcomes.

Common features of successful citizen science projects

- **Clearly defined scientific goals**
- **User friendly platform**
- **Availability to educational materials**
- **Providing a social platform**
- **Facilitating the dissemination of results**

6. Suggestions for improved science-to-policy dissemination

One of the overall aims of scientific projects is to provide knowledge to or in other ways influence policymakers. The amount of literature covering effective science-to-policy communication is relatively large and a comprehensive overview of the literature is outside of the scope of this report. However, one of the key elements for effective science-to-policy strategy for scientists is to establish a connection to policymakers[13]. It is of great importance that scientists establish credibility for their work and engage or make use of networks with decision-makers and other actors, for example non-government organizations. As previously stated, policymakers often have too little time or resources to read through the scientific literature, and may therefore have more use for policy briefs or direct interaction with scientists that they trust.

At a given timepoint, a specific problem may become impossible to ignore, or a policy solution may appear which is practical to adopt. This could open up a window of opportunity for policy change[14]. An example could be that the general population starts to become aware of the hazards connected to PFAS contamination in the environment, or people notice the decline in pollinating insects which may be linked to the use of certain groups of insecticides. Windows of opportunity may also arise due to political events such as a change in political leadership or the appearance of a political agenda such as the EU zero pollution agenda. Some advice for scientists wanting to seize a window of opportunity are as follows. It is often necessary to respond quickly once an opportunity appears. It is therefore valuable to follow the political debate and keep oneself updated on coming policy changes. In a broader term, this can be referred to as “horizon scanning”. Some university departments or research institutes may have designated roles for this and may, for instance, subscribe to specific news services to help keep up to date with relevant fields. It could be more effective to build relevant coalitions and network with decision-makers to get firsthand information on upcoming needs that exist. It is always beneficial to plan ahead and collate existing solutions so that there even may be a possibility to influence the upcoming agenda[13].

One of the most important aspects is to frame the research effectively so that policymakers perceive the knowledge generated through the research as relevant. Knowledge uptake is most efficient when it is conceived as being salient knowledge, meaning that it answers to knowledge needs that the decision-maker has. If a specific research group has established itself as providing relevant and credible results on time, then decision- or policymakers may turn directly to that scientist for future research needs, even though public procurement procedures may exist to limit the extent to which funds may be provided.

As also stated earlier, there are many ways to interact with policy makers, including through dedicated seminars, policy briefs, white papers, social media updates, review papers, etc. Desired stakeholders can also be included on reference panels or in steering groups for projects. It is often beneficial to establish report to specific stakeholders through a dedicated effort.

7. Suggestions for improved communication and dissemination of the AquaticPollutants projects

As shown earlier, some of the AP projects have ambitious and thorough communication plans. It is not possible to assess the effectiveness of the communication efforts regarding, for instance, the non-scientific outreach of the projects. The suggestions presented in this report and the summary of some scientific studies targeting different knowledge transfer methods may provide some guidance to the projects on how to get an effective outreach through the different communication channels that they have chosen to include.

From the mapping activities that the TransNet has performed with water stakeholders, the following general conclusions could be made: The key information and communication channels are often the water stakeholder networks or dedicated journals, newsletters and conferences. This also includes social media shared through these networks or by members of the networks. The water stakeholder networks are, for instance, associations or organizational networks. The Swedish trade organization for water and wastewater operators, Svenskt Vatten, could be an illustrative example having members from close to 90% of the municipalities in Sweden. Svenskt Vatten is in turn a member of EUREAU, the European Union of National Association of Water Supplies and organizes workshops, seminar series and conferences on a yearly basis. Conferences are identified as important information and communication channels as well as collaborative projects involving research groups, institutes and water stakeholders. Dedicated web sites are also lifted as important sources of information.

On the EU level it was highlighted that established trustworthy relationships were necessary for providing access to reliable information. The best way to connect private and public actors were through project partnerships and professional networks. Social media was deemed important for identifying the projects or professionals active in a specific field. EU networks were important for providing information on up-to-date methods or technologies. Initiatives such as innovation prizes and competitions could serve to raise awareness around certain issues.

When it comes to the identified needs from the water stakeholders, the lack of centralized data sources, as well as sharing of information and coordination between countries was identified. The slow communication between research scientists, water suppliers and authorities made progress difficult concerning new legislation or guidance. Difficulties in finding important knowledge published in grey literature was highlighted and there is often a language barrier between countries. Often scientists had difficulties in presenting clear recommendations as they are bound by doubt and scientific rigor.

Below is an overview of the communication activities planned by the AP projects, reasonable target stakeholder groups, which communication category each activity may represent and a comment on how fit each tool is to transfer knowledge pertaining to CECs, AMR and pathogens.

Table 2. Overview of common communication methods applied by the AquaticPollutants projects.

Method	Targeted STKH Group	Type of communication activity	One-way[1] / Two-ways communication	Outreach	Duration	Comment
Newsletters	Associated organizations, project partners, funding agencies, agencies, (general public)	Communication	One-way	Depending on how many that sign up	Ephemeral (readers hardly consult old editions)	Important to market the newsletter and to publish regularly from the start of the project. Good to communicate about events, progresses of the project, and to disseminate the links of publications (if any). It is an intermediate tool to advertise other communication means.
Promotional and educational videos	General public	Communication	One-way (low interactions even when comments are open)	Depends on the number of views	Long: can be accessed / viewed many years after project's end, providing the account remains on the platform.	Could have the potential to reach outside of the initial target groups. Can be costly to make. Requires professional skills. See section 4.4.
Social media	Water stakeholders, general public, decision makers, associated organizations	Communication	Two-ways	Depends on the number of followers	Ephemeral	Could have a potential to reach outside of the initial target groups. Requires frequent posting to generate and maintain many followers. Usually short messages which does not allow for in-depth learning.
Conference presentations	Water stakeholders, scientific community	Dissemination	One-way or two-ways depending how the Q/A time is organised	Hundreds of participants or followers	Long if summaries and presentations are made	Mainly targeting the scientific community. Often very short oral presentations (10-15min) which do not support presenting in-depth information.

[1] One way communication may limit how well the knowledge is transferred.

Method	Targeted STKH Group	Type of communication activity	One-way[1] / Two-ways communication	Outreach	Duration	Comment
					available on the conference webpage.	
Surveys	Target groups	Dissemination	Two-ways	Needs a lengthy initial list of contacts to disseminate the survey link	Short (duration of the survey)	Engages the subject – increased potential for knowledge uptake. Requires many resources. Bet on a snowball effect to increase outreach. Allows for collection of information (personal details to engage communication further, beliefs, behaviours, …). Often requires an online survey tool (with professional account)
Interviews	Target groups	Dissemination	Two-ways	Limited / Targeted	Ephemeral	Increased potential for knowledge uptake. Need to identify key persons to interview first (representatives of a larger group, institution or opinion). Requires many resources.
Workshops	Water stakeholders, target groups, associated organizations	Dissemination	Two ways	Limited to the number of participants	Ephemeral	Increased potential for knowledge uptake. Need to convince the target audience to participate -- insert the workshop within existing events or stakeholder processes. A very clear agenda and duration is needed. Requires many resources. Need professional facilitation skills.
Communities of practice	Water stakeholders, associated organizations	Dissemination	Two ways	Limited to the number of participants	Duration of the practice (project's duration)	Increased potential for knowledge uptake. Need to engage and keep the community involved: need to establish a win-win deal (the community wins knowledge, technologies, power, consulting services, …).

Method	Targeted STKH Group	Type of communication activity	One-way[1] / Two-ways communication	Outreach	Duration	Comment
Scientific papers	Scientific community	Dissemination, (exploitation)	One-way	Possibility to count the reads	Eternal	Meriting for the scientist. Possibility for a wide outreach in the scientific community.
White papers	Policy makers, water stakeholders, associated organizations	Dissemination	One-way	Depends on the initial dissemination list	Long	Important for policymakers and may help to generate a direct contact with them. To be advertised through existing channels / policy advisors, if the white paper was not demanded by the policymakers themselves.
Technical magazines or books	Associated organizations, water stakeholders	Communication, dissemination	One-way	Possibility to count the reads	Long	Shorter articles than the scientific ones. Need to be tailored to the readers of the magazine (level of education, interests, …).
Local or national press releases	General public	Communication	One-way	Unknown	Short	Could generate an outreach to the general public. Outreach depending on if it is picked up and amplified by media. Does not allow for in-depth learning. Needs to be connected to an event, a person, an agenda item to grasp attention.
Training for professionals	Associated organizations, Scientific community, Project partners	Dissemination, exploitation	Two-ways	Number of registered trainees	Short (duration of the training)	Very good potential for uptake of information. A limited outreach that requires a lot of resources.
Training for students	Project partners, Scientific community	Dissemination, exploitation	Two-ways	Number of registered trainees	Short (duration of the training)	Very good potential for uptake of information. A limited outreach that requires a lot of resources.
Public site visits	General public	Communication, (exploitation)	Two-ways	Limited (15-20)	Ephemeral	Very good potential for uptake of information. A limited outreach that requires a lot of resources.

Method	Targeted STKH Group	Type of communication activity	One-way[1] / Two-ways communication	Outreach	Duration	Comment
Online databases	Policy makers, agencies, scientific community	Exploitation	One-way	Very large	Long (as long as the database exists)	Can be used to build networks, provide information directly to decision makers, professionals and scientists. Requires skills to navigate the database, identify relevant data, be able to download and exploit the data.
Inclusion on the advisory board of representatives from industry	Industry partners	Dissemination, exploitation	Two-ways	Limited to the advisory board members	Long	Direct contact with stakeholders. Good potential for knowledge uptake. Good potential for exploitation of results. Can be conflicting with research's neutrality.
Demo-sites in collaboration with industry partners	Water stakeholders, Associated organizations, Industry partners, Scientific community	Exploitation	Two-ways	Limited to the participants / visitors	Short (duration of the demo)	Direct contact with stakeholders. Good potential for knowledge uptake. Good potential for exploitation of results. Can be conflicting with research's neutrality.
Popular science paper	General public, Water stakeholders,	Communication, dissemination	One-way	Depends on the number of readers	Short	Good potential to reach parts of the general public. Needs professional skills to present research results in an accessible way.
Participating in international networks	Water stakeholders	Dissemination, exploitation	Two-ways	Wide	Long	Important communication channel for water stakeholders and professionals. Good potential for knowledge uptake

8. References

1. European Commission, Executive Agency for Small and Medium-sized Enterprises, Haardt, J., Weiler, N., Scherer, J., et al., Making the most of your H2020 project : boosting the impact of your project through effective communication, dissemination and exploitation, Publications Office, 2019, https://data.europa.eu/doi/10.2826/045684
2. www.waterjpi.eu/aquaticpollutants-rdi-funded-projects-booklet-1_bd-3.pdf
3. Communicating EU research and innovation guidance for project participants, (https://ec.europa.eu/research/participants/data/ref/h2020/other/gm/h2020-guide-comm_en.pdf)
4. Taddicken M., and Krämer N. Public online engagement with science information: on the road to a theoretical framework and a future research agenda. Journal of Science Communication 20(03)(2021)A05. https://doi.org/10.22323/2.20030205
5. Miller, J.D., Public understanding of science and technology in the Internet era. Public Understanding of Science, 31:3 (2022) 266 – 272.
6. Miller, J.D., et al. The acquisition of health and science information in the 21st century. The information society, 37:2 (2021) 82-98.
7. Brondi, S., et al. Dimensions of trust in different forms of science communication: the role of information sources and channels used to acquire science knowledge. Journal of Science Communication 20:3 (2021) https://doi.org/10.22323/2.20030208
8. Van Rijn M et al. The public uptake of information about antibiotic resistance in the Netherlands. Public Understanding of Science 28(4) (2019) 486 – 503.
9. Djerf-Pierre, M., Lindgren, M. Making sense of "superbugs" on YouTube: A storytelling approach. Public Understanding of Science 30 (2021) 535 – 551.
10. Pavelle, S., and Wilkinson, C. Into the Digital Wild: Utilizing Twitter, Instagram, YouTube, and Facebook for Effective Science and Environmental Communication. Frontiers in Communication. 2020, Volume 5 Article 575122.
11. Huang, t. and Grant, W.J., A Good Story Well Told: Storytelling Components That Impact Science Video Popularity on YouTube. Frontiers in Communication, 5 (2020) 581349.
12. Golumbic, Y.N., et al. Engagement and communication features of scientifically successful citizen science projects. Environmental Communication 14:4 (2020) 465-480.
13. Van der Arend, J., Bridging the research/policy gap: policy officials' perspectives on the barriers and facilitators to effective links between academic and policy worlds, Policy Studies, 35:6 (2014) 611-630.
14. Rose DC et al. Policy windows for the environment: Tips for improving the uptake of scientific knowledge. Environmental Science and Policy 113 (2020) 47 – 54.